

MULTILEVEL ANALYSIS OF BASELINE DATA FROM UTTAR PRADESH

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Framework of Analysis

Why do we use Multilevel analysis for the data ?

The district Primary Education Programme (DPEP), a major initiative formulated to operationalise the national policy framework, stresses on the reconstruction of primary education at the district level. While it seeks to provide access for all children, equal efforts are being placed for enhancing enrolment and retention, and for raising achievement level among learners. In other words, apart from access and increased enrolment and retention, quality of learning is given priority in the context of universalisation. Obviously, it is a significant departure from the past reflecting a shift towards quality education at the primary level. In fact, the emphasis that is being placed on participative process of schooling, learning competence and achievement, toning up teacher competence and training modalities, improved teaching and learning materials, and improving school effectiveness reflects the shift towards quality.

Adopting decentralised planning and management approach, the DPEP formulates, district-specific and population specific plan of actions to attain the targeted objectives. While micro-planning provides the framework for universal access and universal participation, MLL forms the strategy for universal achievement. The task ahead is stupendous and the difficulties in the field situations are manifold. Obviously, to circumvent such situations, the DPEP plans the inputs based on a field data system and research based intervention is an integral component of the project implementation. In fact, baseline data system is a key component of the project formulation process.

Baseline data

A major component of the project formulation process under DPEP is the conduct of a large baseline study on the achievement levels of students. The baseline study provides a field data system that reflects the prevailing achievement level. The emerging evidences are important for developing district-specific interventions keeping in tune with the area-specific nature of DPEP. Such evidences are equally important for planning training interventions and reformulating classroom transactions, and in short, for planning programmes for the overall improvement of school effectiveness.

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Baseline data are analysed to discern potential variables that have major consequences for policy implications. In fact, learning takes place in school and classroom settings. Characteristics of these settings - physical and material facilities, climate and teacher quality - obviously, matter in learning process. Learning act is performed by the learner and the learner's characteristics are equally important. There are also factors related to the district as

well as the state policies that can affect the learning process. When the baseline survey provides a data system pertaining to student characteristics, teacher characteristics and school process along with achievement, it is a methodological necessity to search for a sound technique for discerning the effectiveness of these variables on achievement. Quite often, researches resort to routine analysis of data at the students' level. In this form of analysis, school becomes the unit of analysis and the student level data are aggregated at the school level. Aggregation may miss certain specific

Analysis of achievement data using traditional techniques invariably result in aggregation or disaggregation bias and also assume same effect of school/classroom intervention on all students which is not true. Multilevel analysis helps in resolving such methodological problems.

information that are needed for providing meaningful explanation. Further, analysis of data is not done by nesting students within classrooms, within schools, within districts, and so on. Quite often, it is assumed that educational interventions have constant effect on all students who are exposed to them, and these effects are invariant across the organisational context. Such an assumption does not hold true. Variations exist among students and across contexts, and multilevel effects can also be seen. Therefore, traditional analytic approaches can produce misleading results even in carefully controlled experimental studies on learning. Such methodological problems can be resolved if the treatment of data is based on multilevel modeling.

In this analytical exercise, baseline data obtained from 18 districts of Uttar Pradesh on student, teacher and school characteristics and learner achievement in mathematics and language are analysed using Hierarchical Linear Modeling (HLM).

What are the objectives ?

The baseline data are analysed to

- find out the differences in achievements of class V students in mathematics and language subjects within and between schools
- estimate the achievement gaps between boys and girls as well as among SC, ST, OBC and general category students
- identify the potential school factors which affect mathematics and language achievements of class V students as well as minimise the achievement gap

What are the research questions ?

1. What extent do schools vary in mathematics and language achievements ?
2. What extent do mathematics and language achievements vary for pupils of differing status ?

- 3 What are the school level variables which matter for variation in mathematics and language achievements ?
- 4 What extent do school level variables promote equity in schools ?

What is the sample size?

Baseline data were collected from 18 districts of Uttar Pradesh as per the DPEP guidelines. Multistage random sampling procedure was used for selecting the schools from rural and urban areas in each district. Teachers and students were randomly selected from each school according to the sampling framework. The detailed constituents of sampling in each district are presented in Table 1.

Table - 1 Sample structure of the study

Districts	Schools	Teachers	Students (Class V)
Badaon	51	162	481
Baharaich	45	89	439
Barabanki	51	119	484
Bareilly	49	137	426
Basti	51	138	654
Deoria	45	127	625
Firozabad	51	140	582
Gonda	51	113	533
Hardoi	50	120	615
Lakhimpur	45	112	587
Lalitpur	45	109	453
Maharajganj	46	146	870
Muradabad	46	140	588
Pilibhit	45	114	550
Rampur	45	128	411
Shahjahanpur	51	115	356
Siddharthanagar	45	128	567
Sonbhadra	45	94	470
Total	857	2231	9691

For the HLM analysis, the data of each target group were scrutinised and the mismatching schools were dropped from the total sample. The final analysis is done using the data from 837 schools and 9610 grade V students.

Which are the tools used for data gathering ?

Though the baseline data are collected using many schedules including class II and dropouts, only those data related to students, teachers and schools are used for the analysis. Hindi version of the following schedules developed by the NCERT are used for data gathering.

- 1 Achievement Test in Mathematics
- 2 Achievement Test in Language
- 3 Pupil Schedule (Present)
- 4 Teacher Schedule
- 5 School Schedule

How many indicators are constructed ?

Outcome Variables

The scores obtained by grade V students on language and mathematics are treated as outcome variables. While the maximum score in the mathematics test is 40, the score in language is 84. Mathematics and language scores are standardized at the individual level using the state mean and standard deviation. The average scores obtained from the HLM analysis are expressed as effect size - a fraction of a standard deviation.

Pupil Level Variables

A series of pupil background variables are constructed from pupil schedule (present). The variables - sex, caste, repeaters in the class and preschool experience - are treated as dummy variables. Ordinal measures (Logit Transformation) are constructed for father's education, mother's education and father's occupation. Socio-economic status (SES) is a composite variable of three parental status variables mentioned above. Family size, head of the family and preschool experience are excluded from the treatment due to their negligible influence. Pupil background variables are centered around at the pupil level on the basis of their state mean. This process of "centering" was carried out by subtracting the mean from each score. It does not affect the estimated value of the slope but transform the value of the intercept. With this transformation the intercept provides an estimate of mean outcome within each school assuming that the composition of a particular variable in the school is same as the composition in the entire sample. With these estimates it is possible to compare how effective the school would be if they have similar variable composition.

School Level Variables

School level variables are selected from the teacher and school schedules, and some are aggregated from pupil schedule. The first two are contextual variables i.e. Mean SES and percentage of SC/ST children which are constructed by aggregating data from pupil level to school level. Rest of the school level variables are clustered into four categories - a) Teacher Quality, b) School resources, c) School climate and d) Intervention launched in the schools. Teacher qualification, teaching experience, in-service education and stability of teacher in terms of duration of service in the same school are the components of teacher quality. School resources consist of six variables such as teaching material for teachers, instructional materials available in school, physical facility, number of teachers, pupil teacher ratio and percentage of female teachers. Academic press in terms of specific attention to language and mathematics subjects, test and feedback, homework given by the teacher, pupil doing homework, teacher commitment, parent involvement and leadership of head teacher (eight variables) are clustered in to school climate. The three variables constituting the intervention category consist of operation blackboard, facilities available under operation blackboard and scholarship to students. Among these variables, operation blackboard is treated as dummy variable. The rest are operated as continuous variables. Composite variables are formulated by giving proper weightage through logit distribution. All variables are centered at the school level on the basis of their state means. The description of all the variables with mean and SD are presented in Appendix - I.

How did we analyse the data ?

The data were collected to determine the effect of school level variables (group level variables) on pupil's achievement in mathematics and language (outcomes at pupil level). These data are obviously, *hierarchical in nature - pupil nested within the school - and multi-level regression analysis fits hierarchical linear model* (Bryk & Raudenbush, 1992). The hierarchical model partitions the outcome variance in to within and between levels, and statistically separates 'true' variance of the micro parameters from sampling variance. The predictors defined at group level explain the true variance in the micro parameters. The HLM software (Bryk, Raudenbush & Congdon, 1994) are used for this purpose. The extent of variation on the two outcome measures (mathematics and language) across schools is estimated at the initial stage using 'null model'. In this model no variable is adjusted at any level and the variance on outcome measures is partitioned into within and between schools. Second model aims to identify good school by controlling the pupil background characteristics. In other words, it estimates the "Type-A " effect which means " the effect of schooling policies and practices, the school composition, the effects of exogenous social and economic factors, and any unmeasured effects associated with school X" (Willms, 1992, P 40). Third model controls the school context and determine "Type B" effect (Willms, 1992), means the effect of school policies and practices as well as any unmeasured effects. Further, adjusted school mean is regressed on school level variables under school level models. The mathematical formulations of the various models are given in Appendix II.

ANALYSIS OF DATA AND INTERPRETATION

What do the outcome data reveal in general ?

Descriptive analysis of mathematics and language achievement is done to discern the prevailing trend of achievement. This exercise is done prior to fitting the data in to multilevel regression analysis. Figures 1 and 2 depict the emerging trend. Figure - 1 represents the distribution of mathematics and language scores of the entire grade V students. It is a cumulative frequency distribution curve containing percentage of scores in 'X' axis and corresponding percentage of students in 'Y' axis. The curve shows the percentage of students up to a given percentage of scores in mathematics or language. For example, while in language only 6 percentage of students scores 30 percent below, in mathematics the size of students scoring 30 percent below is 50 per cent. Obviously, as compared to language, half of the grade V students scores 30 per cent below in mathematics. It means that these students are considerably weak in mathematics as compared to language. The gap between mathematics and language emerges at 20 percent of scores, widens up to 40 percent of scores and it gets minimized at 50 percent of scores. Then the curve gradually gets flattened. It is striking to note that the size of students attaining above 60 percent of scores is negligible.

In language too low performance level is visible. However as compared to mathematics, these students perform relatively better in language. Language scores are further examined in terms of its components - word meaning and reading comprehension. While 40 items are used for identifying word meaning and reading comprehension is figured out by using 44 items. The cumulative distribution curves for both scores (Figure - 2) depict that the gap between word meaning and reading comprehension gets widened from 30 to 50

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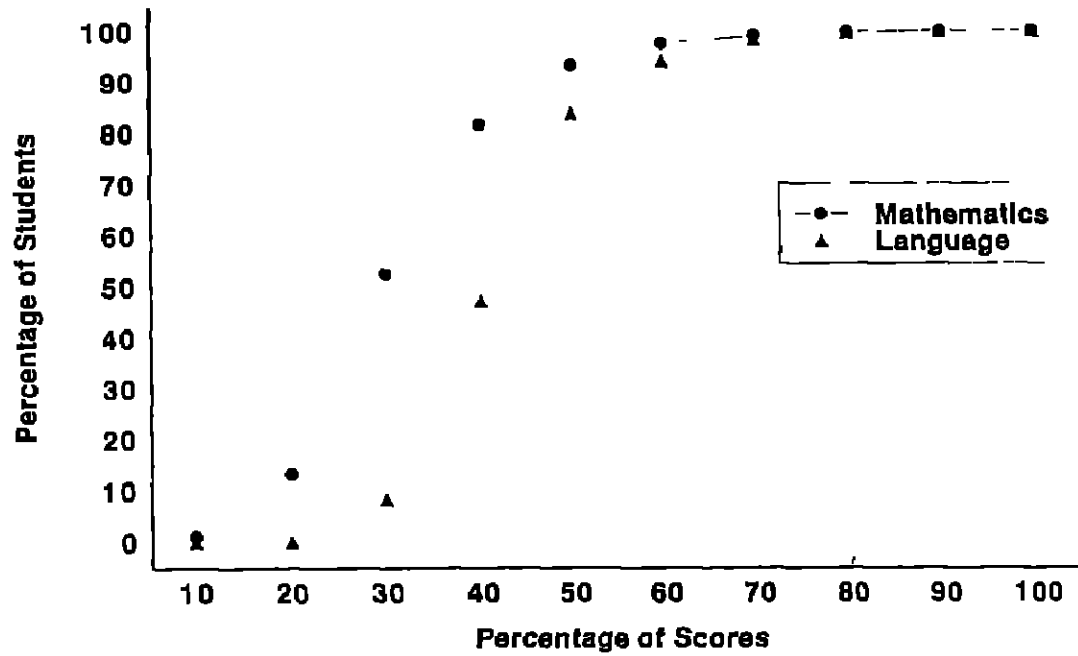
per cent of scores. For instance, figure - 2 indicates that 90 percent of the students scores 70 per cent below in word meaning while the percent of score is below 50 for 90 per cent of students in reading comprehension. Though, these students are relatively better in word meaning, their performance in reading comprehension is much less. Obviously, specific intervention strategies are needed for improving reading comprehension and also the word meaning. Training programmes for teachers need to address this aspect if the concern is to improve quality in language learning.

Does the distribution of outcome measures differ across districts ?

The sample was drawn from 18 districts and the baseline data are analyzed using district as unit. However, the district is not treated as one of the hierarchy in the HLM analysis. To examine the distribution of outcomes in different districts, box plot is prepared for mathematics and language separately (Figures 3 & 4). In these box plots the top and

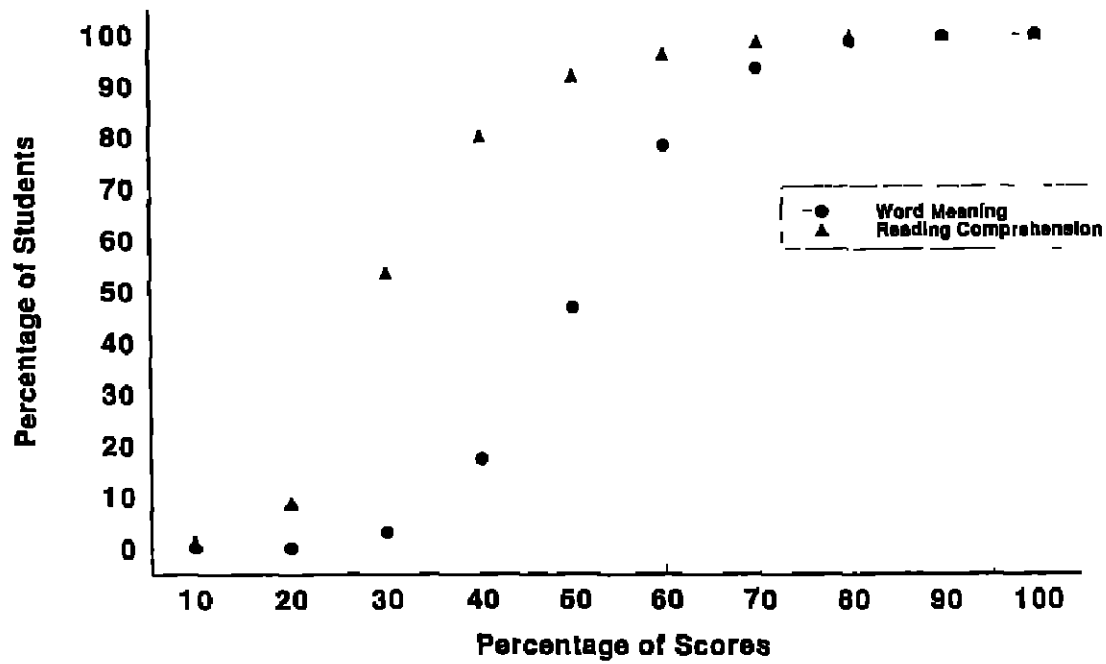
**Mathematics and Language scores of Grade V students
In 18 Districts of Uttar Pradesh**

Figure - 1



**Word Meaning and Reading Comprehension scores of Grade V students
In 18 Districts of Uttar Pradesh**

Figure - 2



bottom of each box represents the upper and lower quartiles (i.e. 75th and 25th percentile) of the distribution for each district. The line in the middle of box is the median (50th percentile). The length of tail above and below shows the range of data from 75th to 90th percentile and 25th to 10th percentile for each district. In each figure, two reference lines are drawn representing the fifty per cent of the total scores and minimum passing marks (30 % of the total scores).

In mathematics (Figure - 3), the median points of all the districts are quite below the line of average scores (50 per cent of the total scores). The median point ranges from 11 to 15 marks in all the districts. It is strikingly visible that 50 per cent of the students and in certain cases even more, have failed in mathematics in districts such as Badaoun, Barabanki, Barailly, Basti, Firozabad, Gonda, Hardoi, Lalitpur, Rampur and Shajahanpur. However, Maharajgunj district stands apart from the rest of the districts in the sense that, students of this district show relatively higher scores in mathematics than the rest. The prevailing trend mirrors that the performance level of grade V students in mathematics is quite low in these districts.

The prevailing trend mirrors that the performance level of grade V students in mathematics is quite low in these districts. Though only a few students fail in language, the scores of those who pass are not that high either.

With regard to language scores, the emerging trend is not quite different (Figure - 4). Seventy fifth percentile of students in each district except that of Maharajgunj district is below the fifty per cent of the score. Unlike mathematics, only a few students (within the range of 10 to 20 percent) have failed in language. The median points of all the districts fall within the range of 30 to 40 marks. Though only a few students fail in language, the scores of those who pass are not that high either.

What is the magnitude of variation that exists within and across schools ?

The basic purpose of the study is to explore the extent of variations in mathematics and language outcome measures and to identify the attributable factors that are important for planning intervention. Equation for each school is formulated and the average is estimated within the multilevel analysis framework to seek the extent of variations within and between schools. Table - 2 shows the results of null and level-1 models in two parts. Null model does not include any variable at any level for adjustment and it simply partitions the outcome variance into within and between schools. The estimates are unconditional. In level-1, pupil background characteristics are adjusted to estimate the school residual on outcome measures which are mainly due to school context, policies and practices. First part of the results shows fixed effects which denotes the average of within school effect. Second part examines random effects - the extent of true parameter variance across schools.

The null model reveals that the fixed effects, with reference to average school mean for mathematics (-0.08) and language (-0.05), are significant. This is noted as B_0j in the equation (equation in Appendix II) and it denotes average of weighted mean of each school.

The significant coefficient reveals that the average school mean is below the grand mean (sample school mean). It means that the average school means for language and mathematics are located at 5 and 8 per cent of the standard deviation (SD) below the mean respectively. The model statistics indicates that the average reliability of the intercept is .84 and .78 for mathematics and language respectively. The high reliability index supports the precise estimation of each school mean.

There exist variations across schools to the extent of 38 per cent in mathematics and 31 per cent in language.

Table - 2: HLM Results of Null and Pupil Background Models

Fixed Effects	Outcome Variables					
	Mathematics			Language		
Null Model	Coefficient	SE	P Value	Coefficient	SE	P Value
Average School Mean	-0.08	0.02	0.001	-0.05	0.02	.02
Pupil Background Model						
Average School Mean	-0.08	0.02	0.001	-0.04	0.02	.03
Girl	-0.18	0.02	.0	-0.14	0.02	.000
SC	-0.08	0.02	.0	-0.11	0.02	.000
ST	-0.11	0.05	0.03	-0.19	0.05	.001
Repeater	-0.13	0.03	.0	-0.16	0.03	.000
SES	0.04	0.01	.0	0.07	0.01	.000
Random Effects (Estimated true parameter Variance)						
Null Model	Variance	df	Chi-Square	Variance	df	Chi-Square
Between School (Av School Mean)	0.38	836	7777.09	0.31	836	53793.78
Within School	0.58			0.68		
Pupil Background Model (Level - 1)						
Between School (Av School Mean)	0.37	661	6742.11	0.29	661	4144.13
Girl	0.13	661	1051.44	0.1	661	871.75
Within School	0.55			0.65		

Variations of these means across schools are estimated as random effects and they are highly significant. It means the average scores of some schools are above the mean and some are below. In mathematics, 38 and 58 per cent of total variations are between and within school respectively. In language it is 31 and 68 percent of the total variation. Within school

variation is found to be higher than the between school variation and in fact, several research studies on school effectiveness have invariably pointed out the same trend of variation in within and between schools. Significant between school variation implies that the differences in school context, policies and practices do matter for the differences in school achievement.

What extent do the outcome measures vary for pupil of differing status ?

In each school there exist differences among students and within school variation is due to such differences. For example, schools enrol girls and disadvantaged students with varying degree of socio-economic background characteristics. Such differences, obviously, affect the school and are likely to influence the estimation of school variance that is being accounted for school policies and practices. Certainly, it is a methodological necessity to adjust such factors at level -1 for estimating the school mean precisely and subsequently regress the adjusted school mean on school factors. Besides, within and between school variations of pupil of differing status need to be examined. The formulated level-1 variables are adjusted and the results are presented in pupil background section of the table -2.

It is observed in table-2 that the significance of average school mean does not change even after the adjustment of pupil background factors. These variables have a negligible effect on the variation of outcome measures across schools. Girls, as compared to boys score 18 per cent of the SD below the mean in mathematics. In language, it is 14 per cent below the mean. Further, the difference of scores between boys and girls varies significantly across schools in both the subjects. It means in some schools girls perform better than boys and in other schools the reverse is true. However, the remaining four variables - SC, ST, Repeater, and SES - do not vary across schools. SC students, as compared to general category students, score 8 and 11 per cent of the SD below the mean in mathematics and language respectively. The students from ST category score 11 per cent (in mathematics) and 19 per cent (language) of SD below the mean in comparison to general category. The students who are repeaters perform 13 and 16 per cent of SD below the mean in mathematics and language in comparison to non repeaters. The insignificant variation of these variables across schools indicates that these disadvantaged student groups are at low level of performance in both mathematics and language in comparison to their reference category (general students) in all the schools. Though the SES slope has positive association with both the outcome measures, the effect size is not that high. For example, one unit increase in SES will increase the achievement of student only by 4 and 7 per cent of SD above mean in mathematics and language respectively within the school.

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The random effect demonstrates that, the pupil background variables which remain

significant in the model are able to reduce only 2.6 and 6.9 per cent of the total variations in mathematics and language achievements respectively across school. In other words, variation in outcome measures due to pupil background characteristics is, certainly much less. Level - 1 variables, responsible for within school variations are able to explain only 5.2 and 4.4 percent of the total variations in mathematics and language. However, large amount of within school variations remains unexplained. It cautions about the probability of missing of potential level-1 variables from the study.

What extent do the outcome measures are affected by school context ?

School context usually denotes student composition and is likely to exert its influence on student learning. For example, the school with high SES student may increase its average outcome scores. Such a school "looking good" provides biased information to policy makers about the effect of school variables on learning outcome. Therefore two variables - MEANSES (mean socio-economic status) and PCTSCST (percentage of SC & ST students in the school) - related to students' compositional characteristics are adjusted in the school level model to estimate the effect of school variables precisely. Table 3 shows the result of contextual effect with the reduction of true parameter variance. Fixed effects reveal that average SES at school level does not have any influence on mathematics and language achievement. Probably, the students of the sample schools do not vary much in their SES. On the other hand, the percentage of SC and ST students in the school has negative association with mean achievement in both the subjects. It means, the school with high concentration of SC and ST students depicts low level of achievement in both subjects. However, the effect size is negligible (Math = -0.003, Lang = -0.004). Figures 5 and 6 evince the relationship between percentage of SCST students in the school and mean achievement in mathematics and language respectively. The figures illustrate that majority of schools have zero to 50 per cent of SCST students and sizable number of schools with less percentage of SC and ST students (below 50 per cent) have outcome scores above the mean in both subjects. These two contextual variables explain only 5.3 and 9.7 per cent of the total between school variations in mathematics and language respectively.

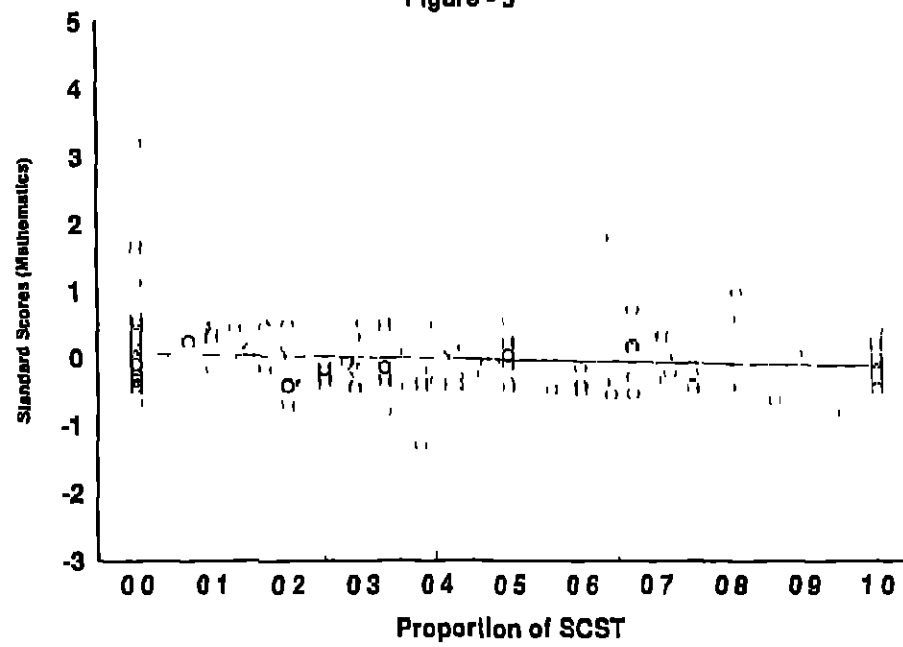
SES at school level does not have any influence on mathematics and language achievement. However, the school with high concentration of SC and ST students depicts low level of achievement in both subjects.

What is the size of residuals ?

The estimated school effect is the residual remaining after the adjustment of pupil background and school context variables. Residuals stand for the mean outcome (either math or language) adjusted for the above mentioned variables. The variability of outcome measures across schools due to variations in school policies and practices are to be isolated further. These residuals are dependent on the type of variables.

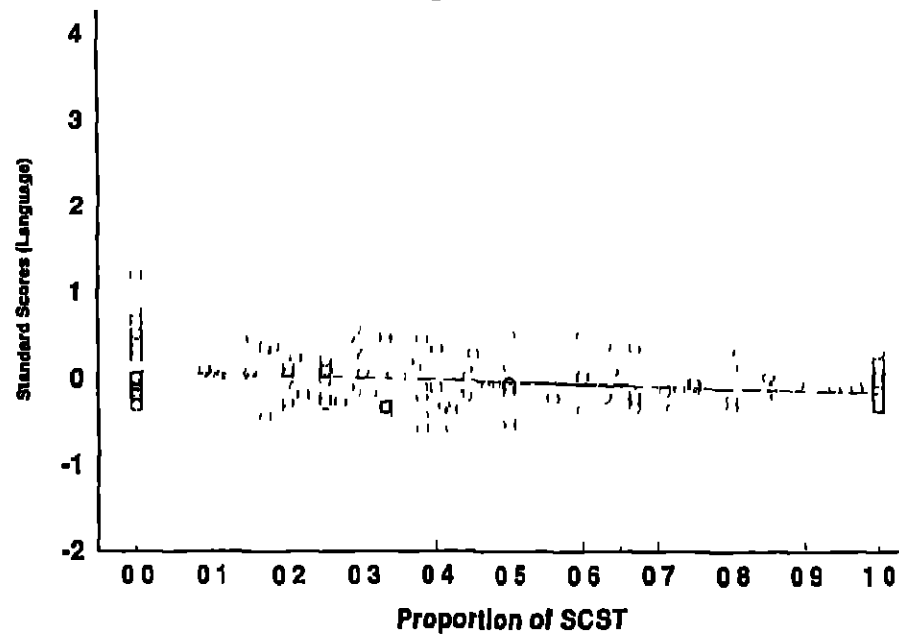
Concentration of SCST students and School Mean (Mathematics)

Figure - 5



Concentration of SCST students and School Mean (Language)

Figure - 6



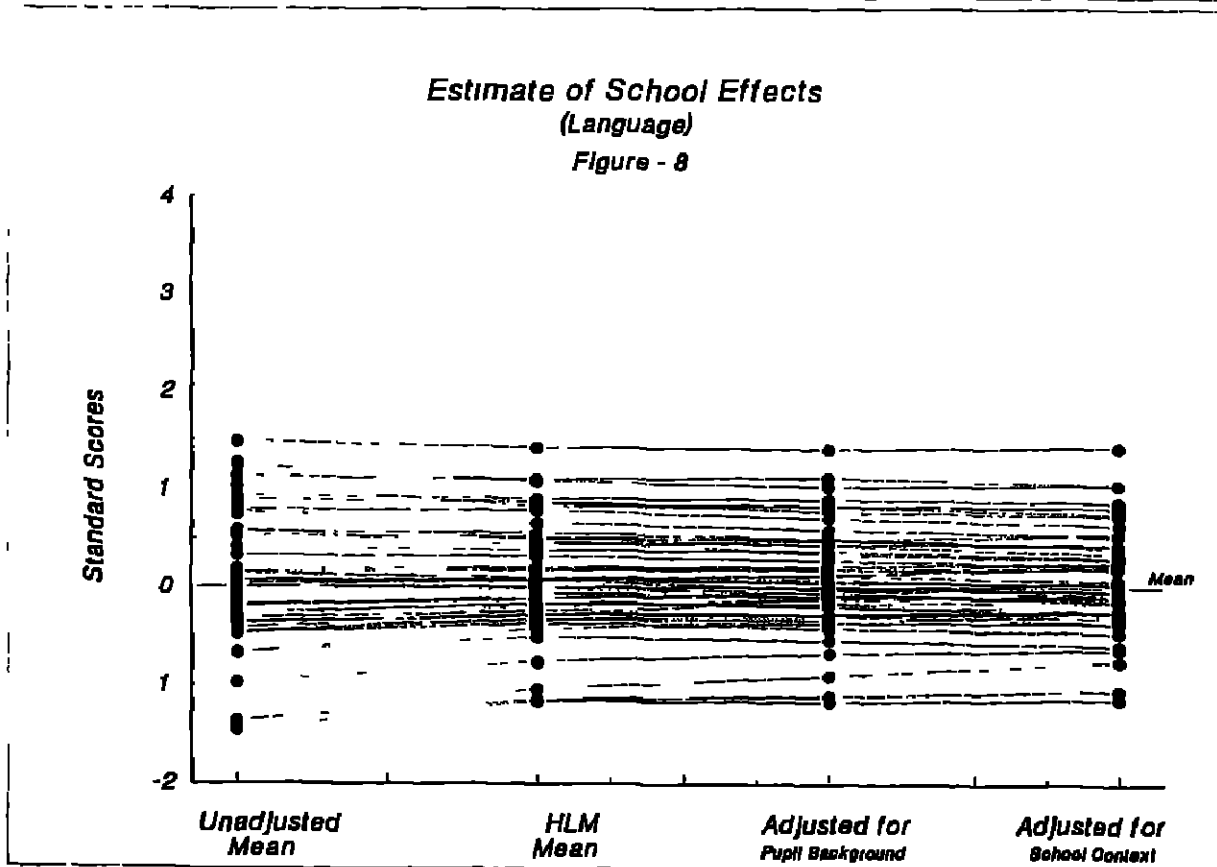
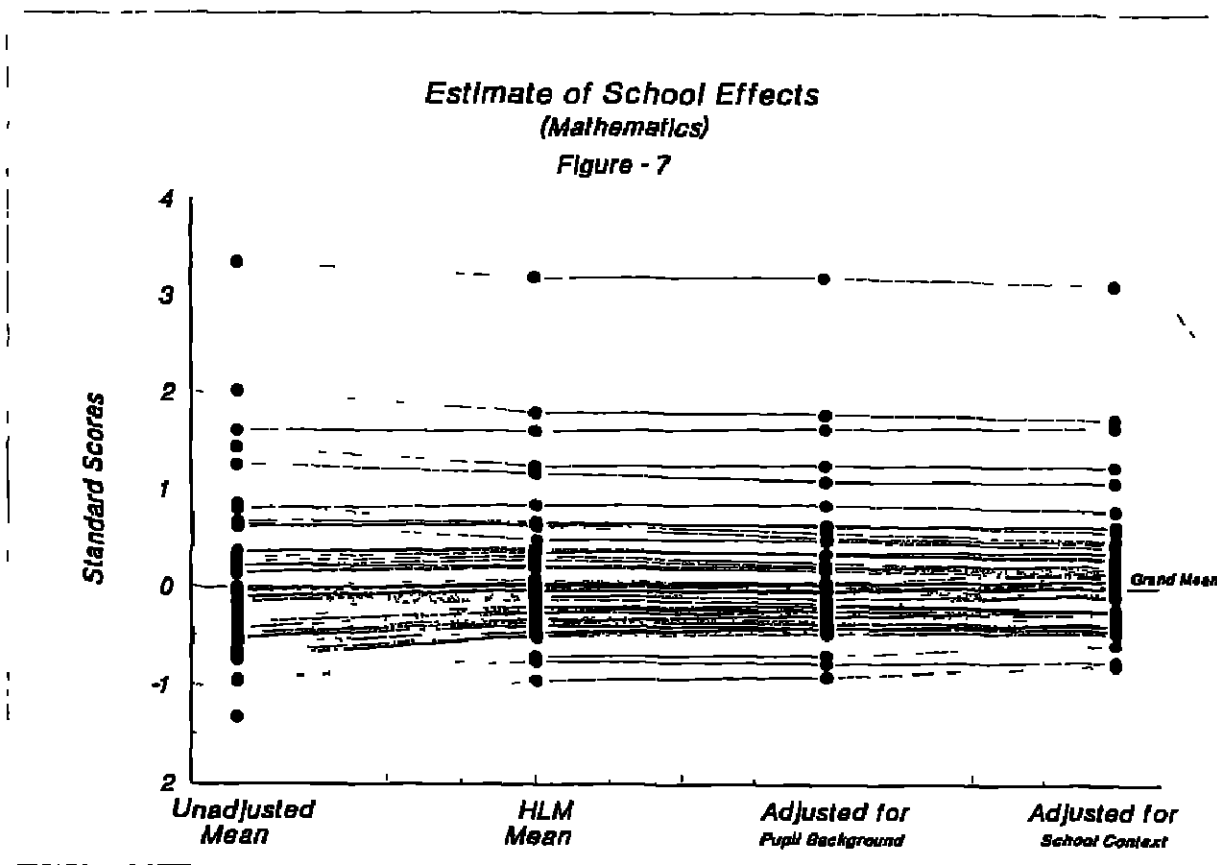
adjusted. If we miss certain potential variable(s), further inclusion of such variables would change the school residual. To examine the effect of such variable(s) at respective levels, the school residual derived at different stages are plotted for both mathematics and language separately (Figure 7 and 8). Though the study is based on 837 schools, only 60 randomly chosen schools are plotted for convenience and practical considerations.

Table - 3 . HLM Results of Contextual Model

Fixed Effects	Outcome Variables					
Contextual Model	Mathematics			Language		
	Coeff	SE	P Value	Coeff	SE	P Value
Av. School Mean	-0.08	0.02	.001	-0.05	.02	.03
MEANSES	-0.01	0.05	.86	-0.01	.05	.89
PCTSCST	-0.003	0.001	.002	-0.004	.001	.000
Reduction in Parameter Variance						
Av. School Mean (Null Model)	0.38			0.31		
Adjusted for Pupil Background	0.37			0.29		
Adjusted for School context	0.36			0.28		

Figure-7 depicts the reduction of variance in mathematics at different stages of adjustment. Each dot represents the mathematics mean outcome of each school and the line extending from left to right indicates the mean score of that school at different stages of adjustment. Unadjusted mean stands for the standard score without any adjustment. HLM mean is derived after partitioning the variance within and between school units. Likewise the rest two means are calculated after adjusting the pupils' background and school context variables respectively. The graph reveals reduction of variance at the level of HLM mean but thereafter meaningful reductions are not seen after adjusting pupil background and school context variables. Language achievement is no way different and the same trend is visible for the mean achievement in language too (Figure-8). It clearly indicates that the pupil background and school context variables are not potential enough to reduce the variance in both subjects at school level.

The size of residuals reduce at the level of HLM mean but meaningful reductions are not seen after adjusting pupil background and school context variables



Are these schools effective ?

Though many models are available in the school effectiveness literature, goal model is quite often used in evaluating schools in terms of students' achievement. Since the focus of baseline assessment study is on learner's achievement, it is logically sound to classify the schools as effective and non-effective based on mathematics and language achievement scores. The schools are considered as effective having scores above the mean and those below the mean are treated as non-effective. Table 4 presents the size of effective and non-effective schools based on mathematics and language achievement in each district. What is strikingly visible from the table is that in 10 out of 18 districts, 60 per cent of schools or even more in certain cases are non-effective in both subjects. The prevailing trend is quite disturbing. One may find solace in Maharajgunj district where one may find large number of relatively effective schools in both subjects (Math=78.3%, Lang=67.4%). It simply means that except in the case of Maharajgunj district, majority of the schools in all the remaining districts (17) are not that effective. The exact position of each school on the continuum of effective and non-effective school for both subjects is shown in figures 9 & 10. Both figures illustrate that the maximum schools fall within 1 SD above and below the mean with a few exceptions. By and large, these schools are in normal category (within -1 to 1 SD of normal distribution) implying that they do not differ much in terms of their effectiveness. Obviously attention is needed to provide for need specific intervention for improving the low performance levels in both the subjects.

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Table - 4 Percentage of Effective and Noneffective Schools in Different Districts

Districts	Mathematics				Language				Total School
	Not Effective Schools		Effective Schools		Not Effective Schools		Effective Schools		
	N	%	N	%	N	%	N	%	
Badaun	31	80	20	50	29	56	22	43	51
Baharalch	28	57	19	42	27	60	18	40	45
Barabanki	36	72	14	28	31	62	19	38	50
Bareilly	41	85	7	14	35	72	13	27	48
Balli	32	62	19	37	20	39	31	60	51
Deoria	22	48	23	51	27	60	18	40	45
Firozabad	27	60	18	40	17	37	28	62	45
Gonda	36	72	14	28	36	72	14	28	50
Hardoi	37	75	12	24	42	85	7	14	49
Lakhimpur	31	68	14	31	31	68	14	31	45
Lalitpur	25	55	20	44	31	68	14	31	45
Maharajganj	10	21	38	78	16	32	31	67	48
Muradabad	24	52	22	47	22	47	24	52	46
Pilibhit	22	48	23	51	21	46	24	53	45
Rampur	29	65	15	34	25	56	18	43	44
Shahjahanpur	33	71	13	28	32	69	14	30	46
Siddharthanag	19	44	24	55	18	41	25	58	43
Sonbhadra	18	41	25	58	19	44	24	55	43

(Mathematics)

Mean



(Language)

Mean

The effectiveness of these schools has been explored, further, by plotting school residuals of both mathematics and language (figure 11). The figure points out a positive linear relationship between the mean scores of mathematics and language. It means that the school which performs low in mathematics also performs low in language and vice versa. The figure clearly illustrates that the number of effective schools - those schools which perform higher in both subjects - is much less. The trend of relationship emerging from the figure indicates that the achievement in these schools is probably due to effort and ability of students.

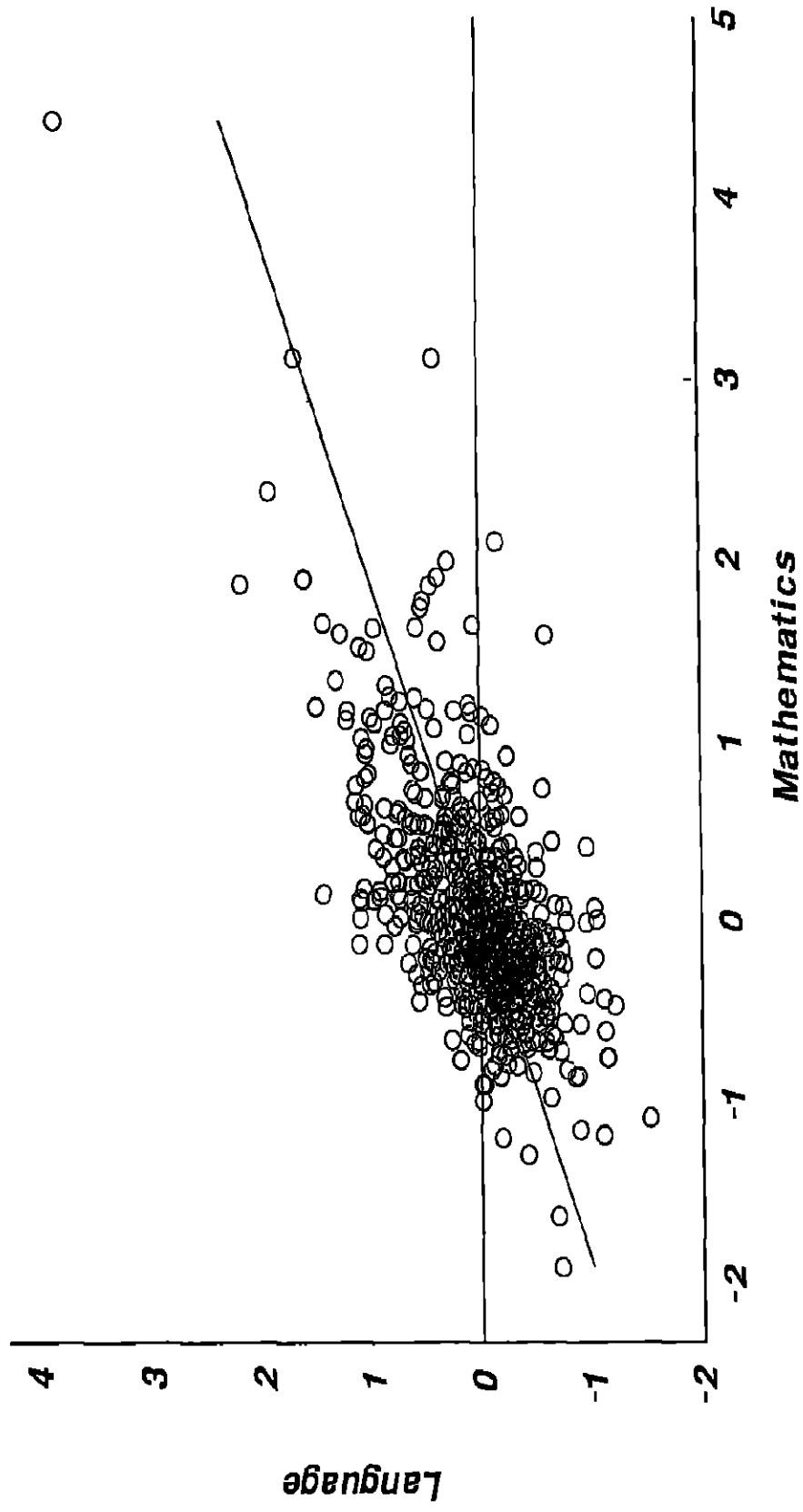
Do the school level variables matter in explaining the effectiveness of school ?

At this stage let us focus on the school residual. The residuals are further regressed on four categories of school level variables - teacher quality, school resources, school climate and state intervention - in separate models. The variables in the model are selected by determining the significant level by using a flexible approach. The variables with p-values less than .20 are selected in each model. From teacher quality (Table 5), it is found that qualification of teachers is positively associated with mathematics and language achievement. It means that schools with teachers of higher qualifications promote achievement. However, the effect size is only .04 and .03 in mathematics and language respectively. What is striking is the negative influence of in-service training of teachers with high effect size (Math = -.21, Lang = -.17). Figures 12 and 13 indicate the negative relationship where schools with 50 to 100 percent of teachers received inservice training have low achievement. Examining the days of inservice training (Figures 14 & 15), it is found that majority of the teachers received 1 to 10 days. Despite such variations in the duration of training, the variable is coded as categorical (received training = 1, not received = 0). Further the negative association can not be explained by considering simply whether they attend training programme or not, without examining the nature and content of the training programme. Attending programme does not boost students' achievement in mathematics or language. Obviously, the negative evidence underscores the need to examine whether the training inputs and strategies provided are specific to mathematics and language teaching and also the extent to which teachers practise what they have gained from training in the classroom situations. Obviously, the content and the nature of training need to be reexamined.

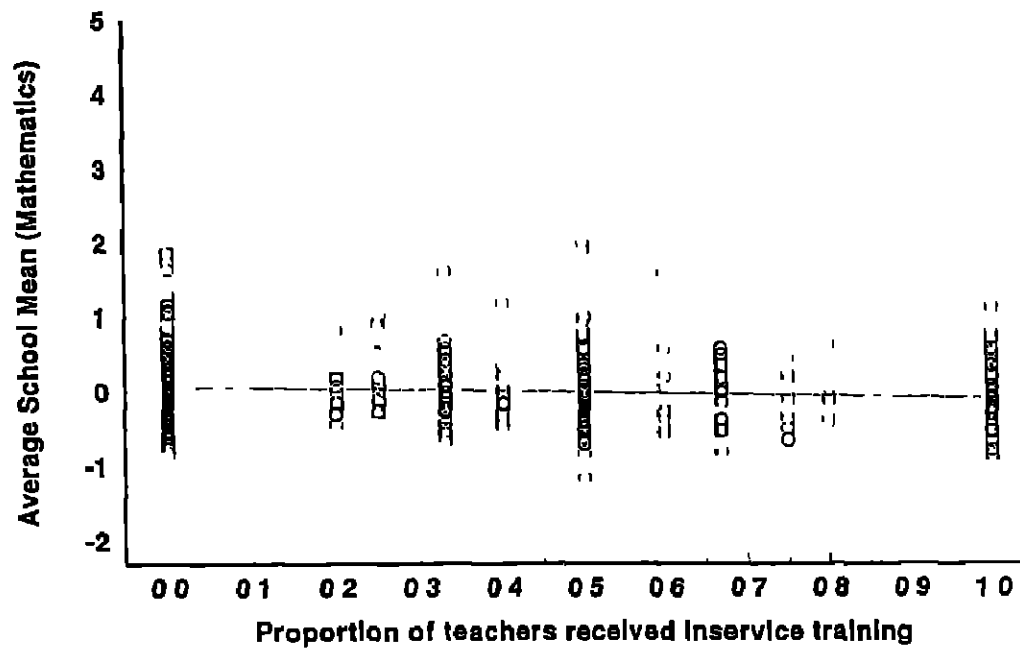
In the category of school resources, number of teachers in school has positive association with mathematics and language achievement (Math = .05, Lang = .03). It means the performance of students is enhanced with adequate number of teachers in school. This evidence assumes considerable significance in the context of multigrade schools. Interestingly, the percentage of female teachers shows negative influence on mathematics achievement but the effect size is negligible. Testing the students and providing feedback emerges as a potential indicator in the school climate category. Increases in mathematics and language achievements are to the extent of 14 and 9 per cent of SD above the mean respectively. Figures 16 and 17 clearly depict the positive association of this variable with both learning outcomes. Engaging students in solving mathematics problem in class reduce the achievement by 19 per cent of SD.

Relationship of Mathematics and Language Scores

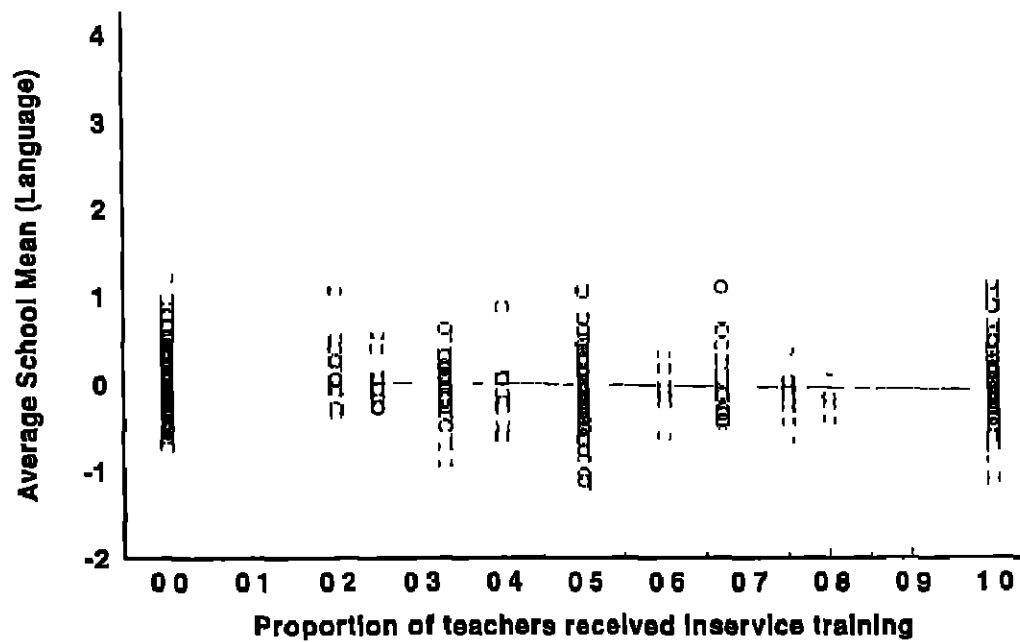
Figure - 11



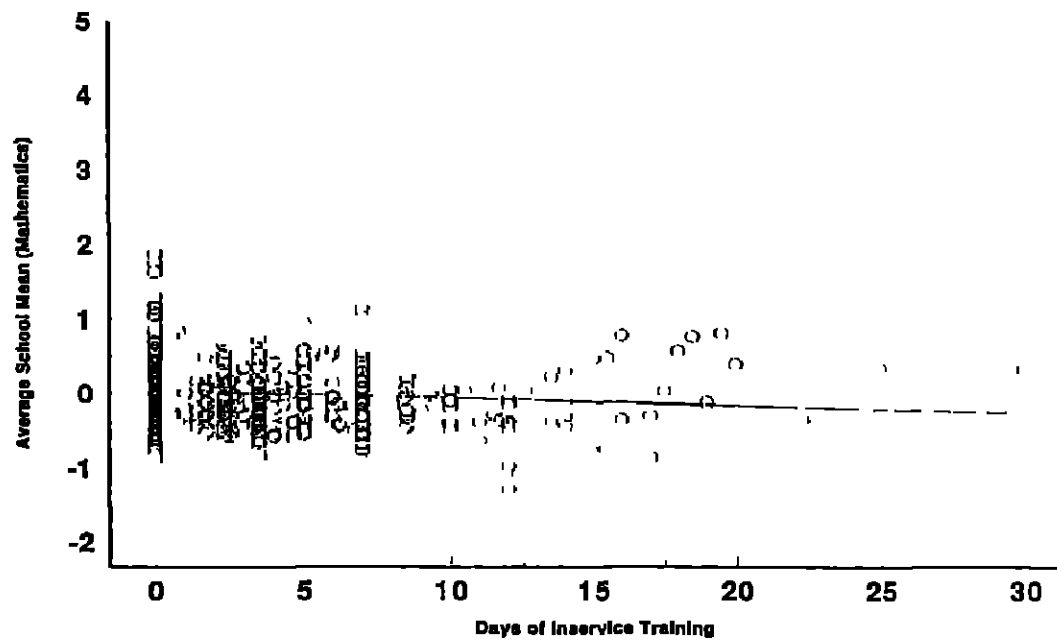
Relationship between Inservice Training and Mathematics Achievement
Figure - 12



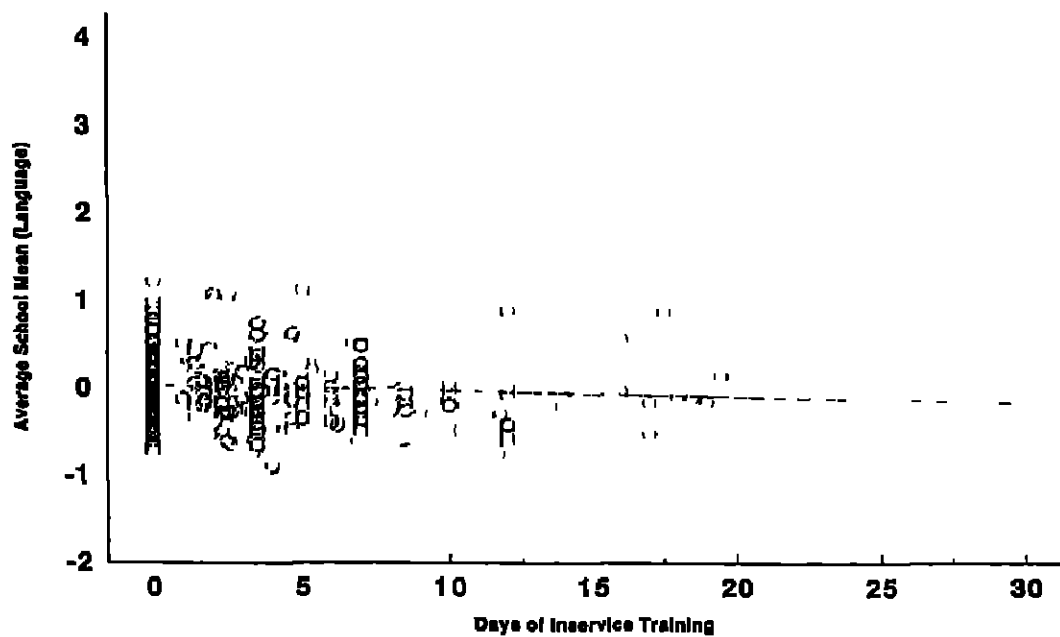
Relationship between Inservice Training and Language Achievement
Figure - 13



**Relationship between days of Inservice training and
Mathematics Achievement
Figure - 14**

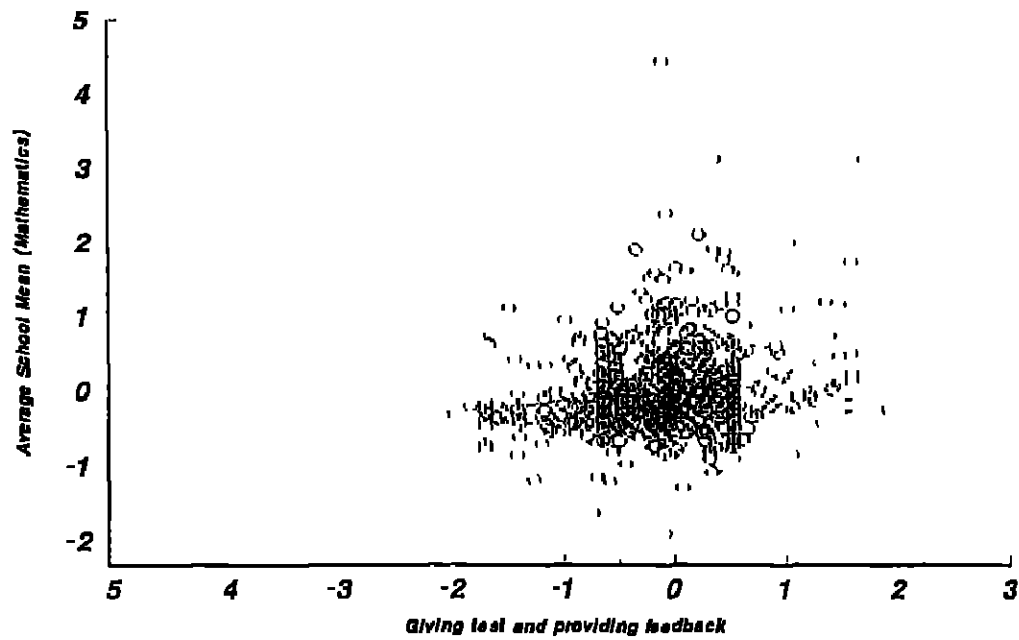


**Relationship between days of Inservice training and
Language Achievement
Figure - 15**



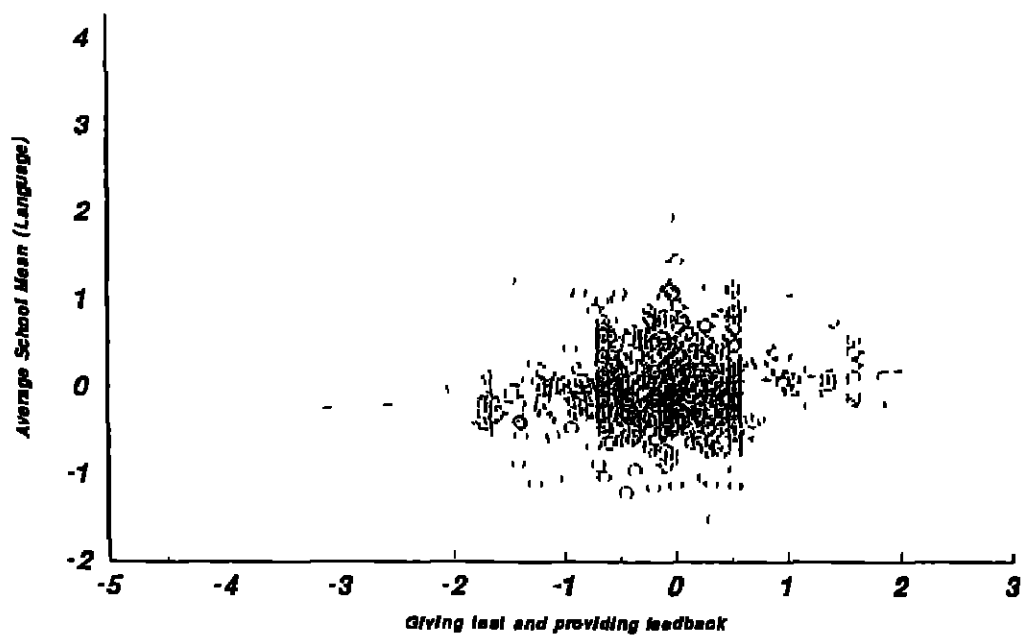
***Relationship between giving test and providing feed back
and Mathematics achievement at school level***

Figure - 16



***Relationship between giving test and providing feed back
and Language achievement at school level***

Figure - 17



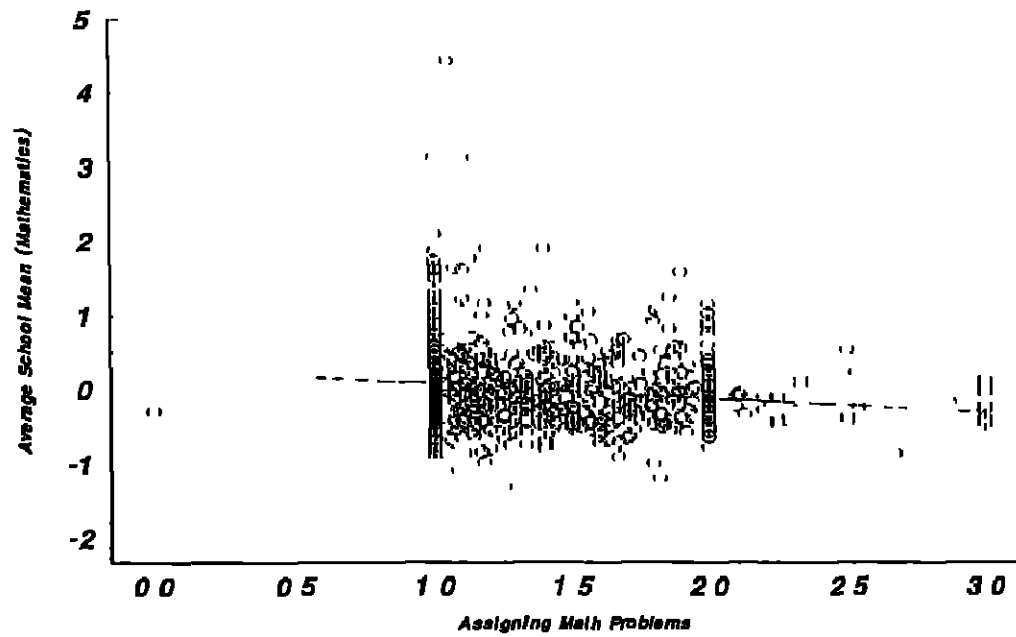
below mean. The figure 18 illustrates that majority of the teachers belong to the categories of responses - 'either do not give' mathematics problems in classroom or even if they give, they give only 'sometimes'. Those who give problems 'always' are negligible in number. It is interesting to note that sizable number of schools from the response categories - 'do not give' mathematics problems in classroom situations or provide 'only sometimes' show relatively higher scores in mathematics. Obviously, in such situations negative influence emerges. However, the time spent on homework enhances the language achievement by 6 per cent of the SD above mean. It does not mean that home assignment is the right strategy for promoting language achievement. What is important is the fact that engagement of learners in learning language, of course, in this case home assignment, does promote language achievement.

Table - 5. HLM Results of Different School Level Models

Fixed Effects	Outcome Variables					
Teacher Quality	Mathematics			Language		
	Coeff	SE	P	Coeff	SE	P
Teacher Qualification	0.04	0.02	.01	0.03	0.01	.03
Inservice Training	-0.21	0.06	.002	-0.17	0.06	.004
School Resources						
Number of Teachers	0.05	0.01	.004	0.03	0.01	.03
Percentage of female teachers	0.002	0.001	.02			-
School Climate						
Solve Math Problem in Class	-0.19	0.06	.001			-
Test and Feedback	0.14	0.04	.001	0.09	0.03	.005
Time Spent on Homework	-	-	-	0.06	0.02	.002
School Intervention						
Covered under OPBLACK Scheme	-0.11	0.04	.02			
Scholarship to Students	-0.004	0.002	.02	-0.004	0.001	.004
Facilities existing under OPBLACK	-	-	-	-0.006	0.004	.14
Reduction in Parameter Variance						
Contextual Model	36			28		
Teacher Quality	35			27		
School Resources	35			27		
School Climate	34			27		
School Intervention	35			27		

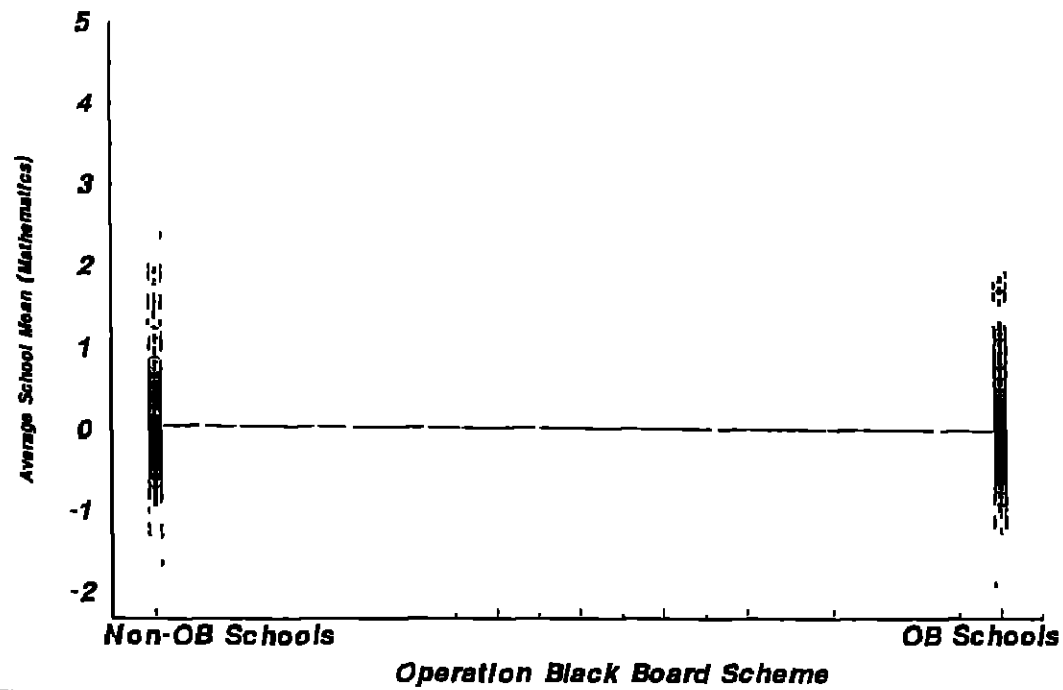
**Relationship between assigning Math problems in class
and mathematics achievement**

Figure - 18



Effect of Operation Blackboard Scheme on Mathematics Achievement

Figure - 19



The intervention schemes are not found effective in augmenting the students' performance in these two subjects. The school covered under operation black board scheme are performing 11 per cent of SD below the mean in mathematics. The figure 19 shows that the school with high mathematics achievement are not covered under the operation black board scheme. Scholarship offered to students may motivate them to attend schools but it does not influence their achievement positively. Negative influence of facilities provided under Operation Black Board on language achievement does exist. Though the size of influence is too less (- 06), the negative direction of influence is a matter of concern. Unless facilities provided include facilities specific to teaching-learning language and their effective utilization during classroom transaction, such facilities would not yield the desired result.

The emerging evidence from the data reveals that inservice training of teachers, and testing students and providing feedback are the two potential indicators that have consequences for explaining achievement of these students

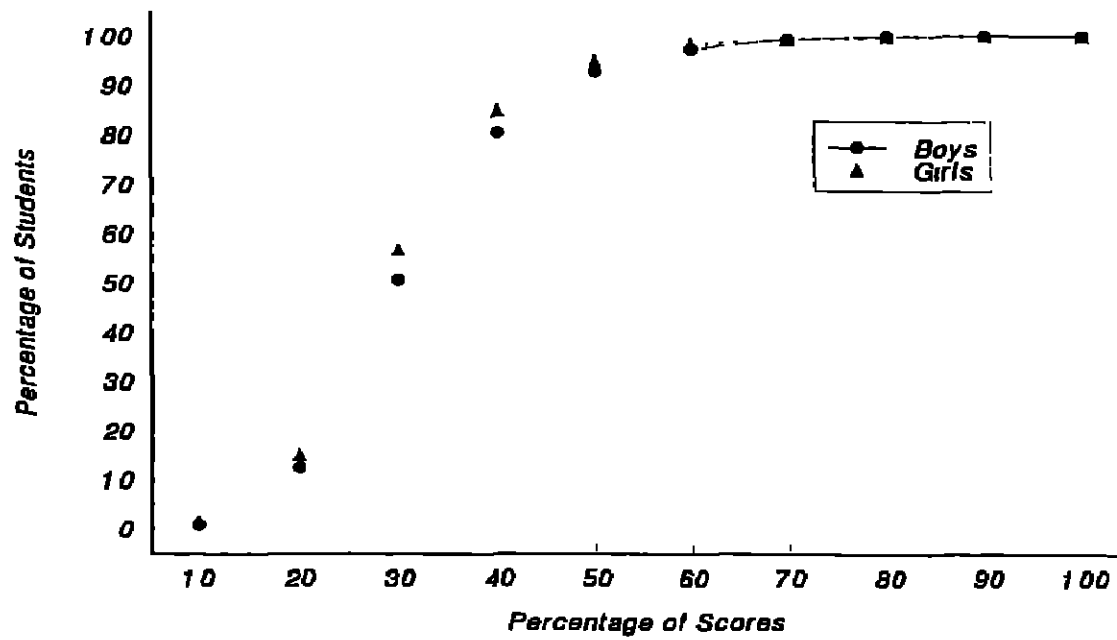
Four categories of school variables are fitted in four different models, and the variance for each model is calculated separately. Of these models - teacher quality, school resources and state intervention - each explains only 2.8 per cent of the total between school variance. Under school climate model, only two variables are able to explain 5.6 per cent of the total between school variance. With regard to language, each model explains only 3.6 per cent of the total variance. It means the sizable amount of variance across schools in both language and mathematics outcomes remain unexplained. Probably, inclusion of schooling process variables may be able to explain more amount of outcome variance across schools. Thus, the emerging evidence from the data reveals that inservice training of teachers, and testing students and providing feedback are the two potential indicators that have consequences for explaining achievement of these students.

Do gaps exist in the achievement levels among the various categories of students ?

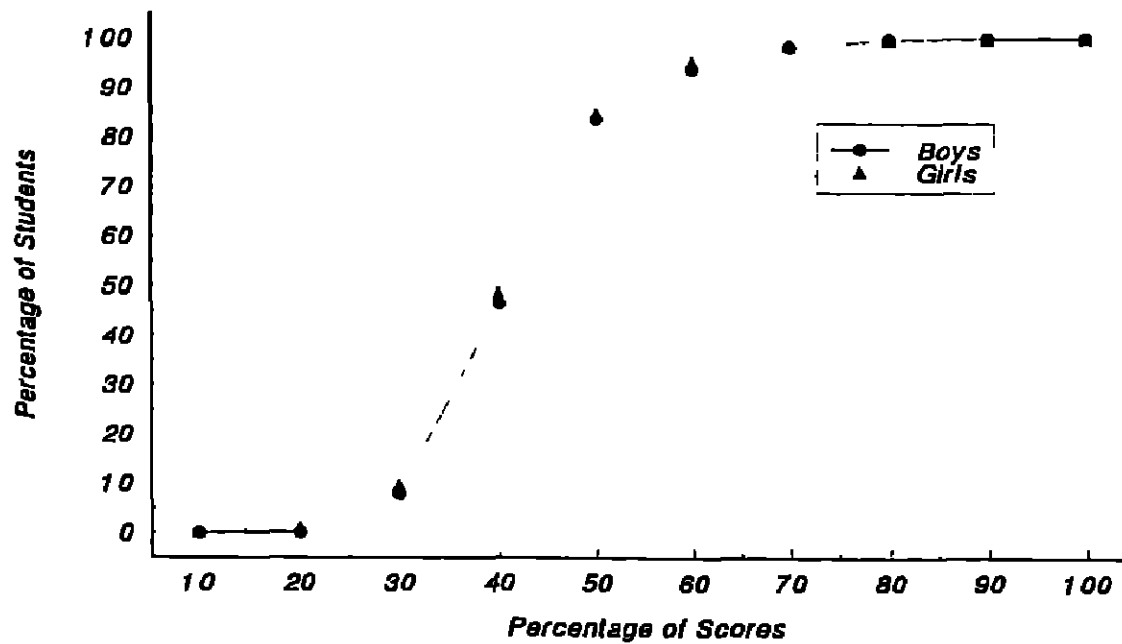
Excellence and equity are the two major goals of school reform efforts. In the earlier sections we have outlined the factors, emerging from the data, that have consequences for excellence in learning. Let us, now, examine the factors that promote equity in the school system. This section addresses the concern whether there exists equity in the distribution of opportunities to various sex and caste groups for learning. Social equity in terms of socio-economic status of students is not considered in this analysis for the simple reason that, the null model (for SES) suggests 9 per cent variation across schools due to SES and it is not significant after the adjustment of pupil background characteristics. As such only the differences between boys and girls, and among the categories of SC, ST, OBC and General students are treated in the HLM analysis.

The differences of various caste and sex groups on mathematics and language achievements are plotted (Figures 20 to 23) and this exercise was undertaken prior to the HLM

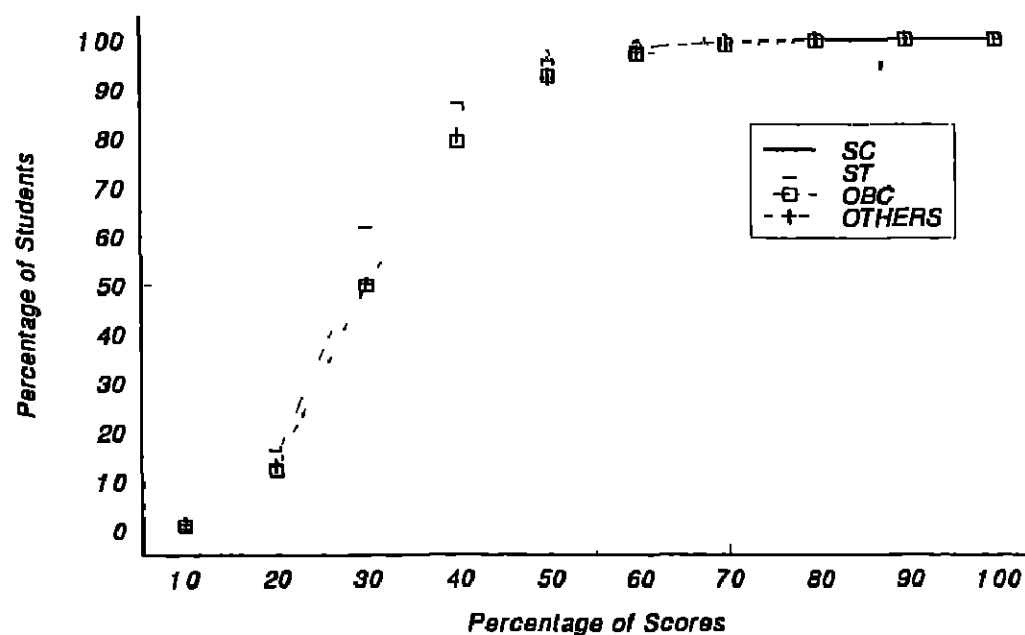
Mathematics Scores of Boys and Girls
Figure - 20



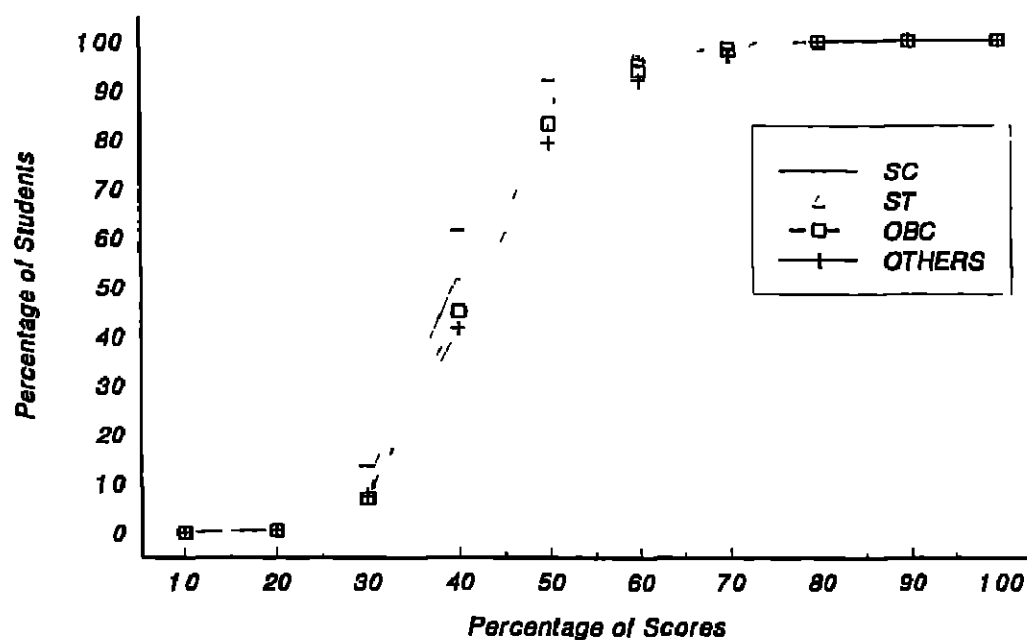
Language Scores of Boys and Girls
Figure - 21



Mathematics Scores of SC, ST, OBC and Other Students
Figure - 22



Language Scores of SC, ST, OBC and Other Students
Figure - 23



analysis While a minor gap between 30 to 40 per cent of scores exists between boys and girls in mathematics achievement (Figure 20), it is approximately zero in language achievement (Figure 21) Within caste categories, OBC and general categories of students do not differ though a small gap can be seen between the scores of SC,ST students and the scores of OBC and general categories of students (Figure 22) In language, the gap between ST and general categories of students widens between 40 to 50 per cent of the score On the whole, as compared to the general category, ST and to a certain extent of SC students, depict low performance levels in both subjects Figures reveal that there exist gaps in the achievement levels in mathematics and language between general category and SC/ST groups It may be noted that these are unadjusted gaps and their significant variations can be established only after adjusting pupil background characteristics Let us now examine the significant variation of gap across schools

Do the gaps vary significantly across schools ?

Two variables (sex and caste) are treated as dummy variables in the HLM analysis with the coding '0' for boys and '1' for girls The coefficient derived from within school regression model is treated as the difference in scores between boys and girls Three dummy variables are formed for the caste groups with the general (others) category as the reference category Due to centering, the estimates of the gap indicate the difference for a hypothetical student of the sample (Girls or SC or ST or OBC) who has average characteristics

In the analysis, the unadjusted gap (no variables except girls or SC or ST or OBC in the model) is calculated first followed by estimation of the gap by adjusting pupil background characteristics (Table 6) Initially the unadjusted slope value is tested for random variation across schools Wherever, random variation is not significant while the fixed effect is significant, the variable is constrained and allowed for constant variation across schools

The unadjusted gaps are found significant within the school for girls, SC, ST and OBC students in both mathematics and language However, Girls, SC and ST students are performing lower than their respective reference categories within the school The reliability of the gap is relatively better for girls than the other three groups Significant variation in this gap across schools in both the subjects is found only for girls It means that the variation among caste categories is within school only Therefore, the caste category variables are constrained for random variation while adjusting the pupil background characteristics Within school, the effect size of In the adjusted gap is larger for girls in mathematics (- 18) where as in language the larger gap (- 19) is for ST students The variation of adjusted gap between boys and girls are 13 and 10 per cent across schools in mathematics and language respectively It means that there exist achievement gaps in mathematics and language between boys and girls

The variation of achievement gap between boys and girls are 13 and 10 per cent across schools in mathematics and language respectively. It means that achievement gaps in mathematics and language exist between boys and girls.

Table - 6 . Achievement gap between Boys vs Girls, SC vs Gen, ST vs Gen and OBC vs Gen. Students

Fixed Effects	Mathematics							Language								
	Slope Reliability	Unadjusted			Adjusted			Slope Reliability	Unadjusted			Adjusted				
		Coeff	SE	P Val	Coeff	SE	P Val		Coeff	SE	P Val	Coeff	SE	P Val		
Girl	.33	-0.16	.02	.000	-0.18	.02	.000	.25	-.10	.02	.000	.14	.02	.000		
SC	.08	0.07	.02	.001	-0.08	.02	.000	.04	.12	.02	.000	.11	.02	.000		
ST	.13	-0.10	.04	.026	-0.11	.05	.027	.16	.21	.04	.000	-.19	.05	.001		
OBC	.06	0.05	.02	.005	-	-	-	.08	.05	.02	.019	-	-	-		
Random Effects																
	Variance	df	chi-Sq	P	Var	df	chi-Sq	P	Variance	df	chi-Sq	P	Var	df	chi-Sq	P
Girl	.13	661	1040.26	.000	.13	661	1051.44	.000	.10	661	864.26	.000	.10	661	871.75	.000
SC	.02	626	639.66	.344	Constrained				.01	626	572.22	>.50	Constrained			
ST	.04	93	70.59	>.50	Constrained				.07	93	101.33	.260	Constrained			
OBC	.01	669	710.31	.130	-----				.02	669	733.01	.043	-- ----			

What are the school factors that promote equity in schools ?

It is evident from the earlier section that the achievement gap between boys and girls varies significantly across schools. Significant variation is explained by adjusting the variables from four categories in the girls slope. Table - 7 reveals that availability of teaching materials in school i.e. books, map, globe, charts etc (total 10 items) bridge the achievement gap between boys and girls in mathematics. It means access to such teaching-learning materials will improve the mathematics achievement of girls. But the small effect size (0.03) can not authenticate the prediction. The figure 24 shows that the trend of liner relationship is too small. Under classroom climate category, assigning and correcting home work has the potential to minimise the achievement gap to certain extent ($P < .10$). Availability of materials under operation blackboard scheme reduces the achievement gap in language ($P < .15$) with negligible effect size. On the other hand physical environment facilities and doing home work widen the achievement gap in mathematics. Other scholarship given to students also widens the achievement gap in language with very negligible effect size. It is important to note that the effect sizes of these variables are too less. Thus, the emerging findings from school factors do not provide any encouraging evidence to reduce the gap in achievement or promote equity. Therefore, it is difficult to figure out important indicators that promote equity in the school.

**Relationship between achievement gap between boys and girls
in mathematics and teaching learning materials available in school**

Figure - 24

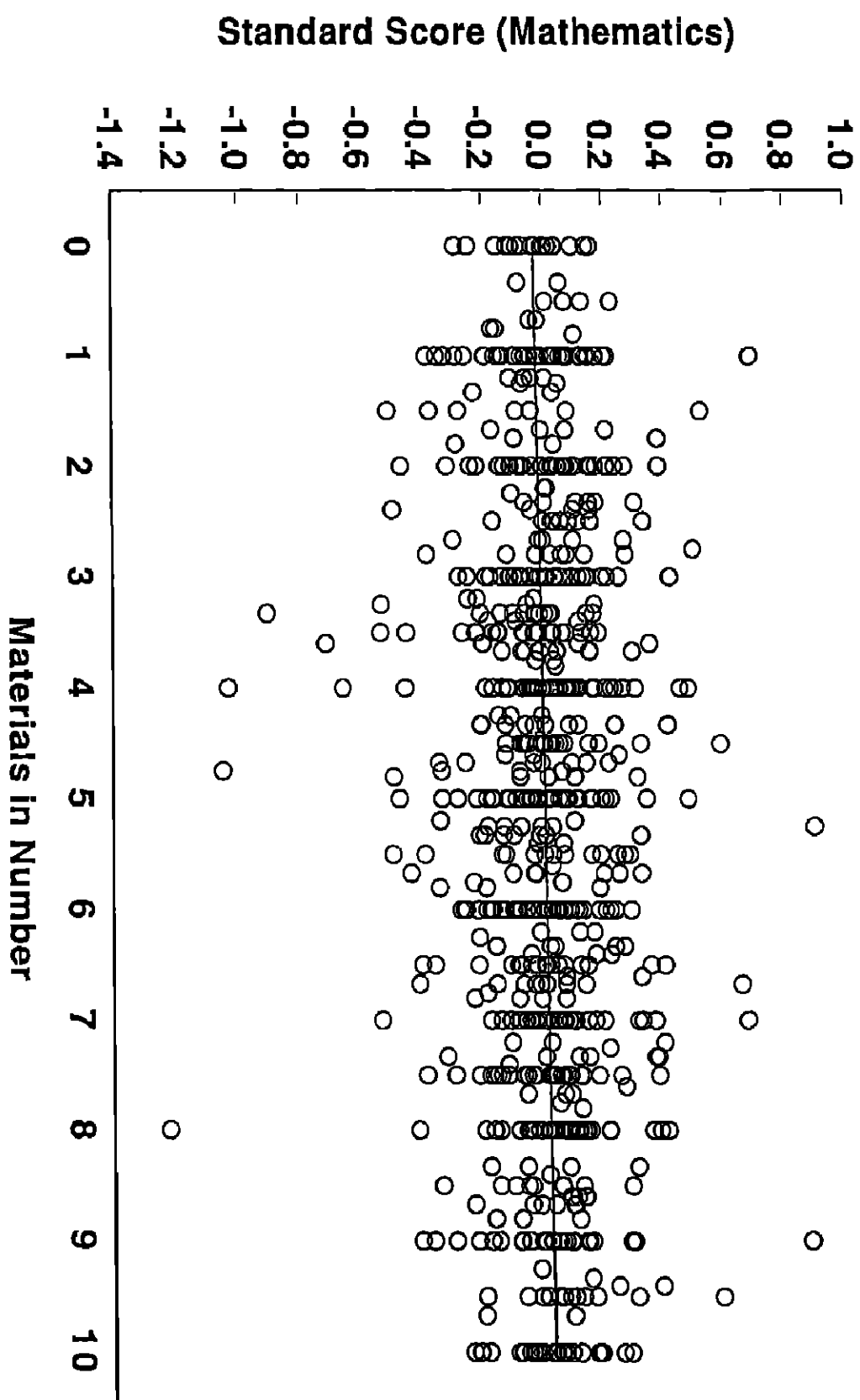


Table - 7 Effect of School Variables on Achievement gap between boys and girls

School Variables	Mathematics			Language		
	Coeff	SE	P Value	Coeff	SE	P Value
Teaching Learning Materials	03	01	005	–	–	–
Physical facilities in school	- 03	01	006	–	–	–
Teacher assign and correct home work	09	05	10	–	–	–
Time spend on home work	- 05	02	05	–	–	–
Facilities under OB Scheme	–	–	–	007	005	15
Other scholarships	–	–	–	- 004	002	03
Reduction of Parameter Variance						
Contextual	13			10		
School Resources	12			–		
Class Climate	12			–		
School Intervention	–			09		

From the random effects, it is observed that the school level variables in each model explain only 7.7 per cent of the total variation of achievement gap in mathematics. The variables in state intervention category are able to explain only 10 per cent of the slope variation in language. Though the results are statistically significant, the small effect size does not validate the prediction for generalising the evidence to school situations. Larger proportion of variation in the achievement gap is not explained by the constructed indicators.

MAJOR FINDINGS AND IMPLICATIONS

The evidences emerging from the analysis of baseline data from 18 districts reveal the following field reality

The performance level of students from these districts, in general, is low in both mathematics and language. As compared to language, they are considerably weak in mathematics. In language, though these students score relatively high in word meaning, their level of reading comprehension is much less.

There exist across school variations in achievement to the extent of 38 per cent in mathematics and 31 per cent in language.

Within the schools, girls and those from SC and ST categories maintain low scores. But the difference is that while girls are at low scores as compared to boys, SC and ST groups are at low scores as compared to general category students.

Within the school, Socio-economic status indicates positive association with mathematics and language achievements but the effect size is quite negligible.

Schools in seventeen districts, except Maharajgunj district, are predominantly noneffective. The size of noneffective schools - 60 per cent of the schools or even more in certain districts - indicates the prevailing field reality in these districts.

Giving test and providing feedback, and inservice training of teachers emerge as the most potential indicators that have major consequences for achievement in mathematics and language. While giving test and providing feedback promote mathematics and language achievement, inservice training has negative influence on both mathematics and language achievement.

Significant achievement gap between boys and girls exists across schools in mathematics and language.

Availability of teaching-learning materials appears to bridge the achievement gap between boys and girls.

Thus, the field reality points out that the schools in these districts are predominantly noneffective in terms of performance levels in mathematics and language. Active subject specific classroom transaction and learning strategies are needed for improving mathematics and language achievement levels in these schools. Attention is to be focussed on reading comprehension for promoting language learning. Within the class, girls and the disadvantaged groups (SC and ST) seek need specific learning conditions in mathematics and language. If the concern is to improve the effectiveness of these schools, active classroom transactions and learning strategies specific to mathematics and language need to be stressed.

What the data mirror is that the prevailing format of inservice training hinders achievement in mathematics and language. The implication is that the inservice training programme for teachers need to be restructured to address the subject specific needs of teachers. Such training programmes need to be designed for effective classroom transactions and for promoting active learning in mathematics and language. What teacher does for providing feedback to students is an important aspect of classroom process and should form a component of the restructured training inputs. Though there exists achievement gap between boys and girls in both subjects, availability of variety of teaching and learning materials bridges the achievement gap. It is important to note that how effectively such materials are used for learning is what matters in this context.

References

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Appendix - I

List of Indicators

No	Variable	Label	Description	Mean	SD
Outcome Variables (Centered at Pupil level)					
1	Mathematics (Standardised)	MATH	Each correct answer get 1 mark (40 items)	12.99	4.69
2	Language (standardised)	LANG	do (84 items)	15.24	8.65
Pupil Level Variables (All these variables are centered at pupil level)					
1	Gender	GIRL	Girl = 1, Boy = 0	0.31	0.46
2	SC	SC	SC=1, Others=0	0.26	0.44
3	ST	ST	ST=1 Others=0	0.06	0.23
4	OBC	OBC	OBC=1 Others=0	0.44	0.50
5	Father Education	DADED	Illiterate=1 Literate=2 Primary=3 Secondary=4 Hr/Sr Sec.=5 Collage=6 Logit transformation standardised	0	1
6	Mother Education	MUMED	Illiterate=1 Literate=2 Primary=3 Secondary=4 Hr/Sr Sec.=5 Collage=6 Logit transformation standardised	0	1
7	Father Occupation	DADOC	unskilled worker=1 poultry farming=2 picking forest produce=3 agn labourer=4 farmer=5 skilled worker=6 street vendor=7 others=8 self employed=9 domestic servant=10 household=11 clerk=12 employer=13 senior officer=14 logit transformation & standardised	0	1
8	Ever repeated a class	REPEAT	REPEAT=1 if yes in any class else=0	0.12	0.32
9	Socio economic status	SES	SES=(DADED+MUMED+DADOC)/valid responses composite & standardised	0.03	0.63
Contextual Variables (All Variables are Centred at School Level)					
1	School Mean SES	MEANSES	Aggregated from pupil to school level	0.31	0.46
2	Per cent SCST	PCTSCST	Per cent of SC and ST in the school	33.14	30.10
Teachers Quality Variables (All Variables are Centred at School Level)					
1	Qualification	TCHQUA	Class VIII=8 class X=10 class XI/XII=12 graduate=14 post graduate=16 Aggregated	11.83	1.38
2	Experience	TCHEXP	1993 year of first appointment Aggregated	19.02	7.73
3	Inservice	INSERVIC	INSERVIC=1 if received during last 3 training years Aggregated	39	36
4	Period in present school	STABLE	Subtracted year of appointment from 1993 Aggregated	8.66	6.32
Resource Variables (All Variables are Centred at School Level)					
1	Access to teaching material	MATERIAL	Add all yes=1* against 10 items (1 Blackboard 2 Teacher's guides 3 Dictionary 4 Books 5 Map, 6 Glob 7 Charts 8 Flash cards 9 Science kit 10 Mathematics kit) Aggregated	4.97	2.64
2	Instructional material available	FACILED	Add all yes=1 for 13 items (1 Maps 2 Globe 3 Charts 4 Play material & toys 5 Games equipment, 6 Science kit 7 Mini tool kit, 8 Mathematics kit 9 Books for library reference, dictionaries Encyclopedia 10 Books for library children's books, 11 Books for library Magazines Journals Newspaper 12 Blackboard 13 Pinup board/Notice board) Aggregated	7.18	3.87
3	Physical facility	FACILPH	Add all yes=1* for 14 items (1 Schoolbell, 2 Mists & furniture for students 3 Chair for teachers 4 Tables for teachers 5 water pitcher ladle glasses 6 dustbin 7 safe drinking water 8 Toilet facilities 9 Separate toilet for girls 10 Electric connection 11 Playground facilities, 12 Annual medical checkup for children 13 Immunization facility 14 First aid kit) Aggregated	6.25	2.36
4	No of Teacher's	NUMTCH	Total of male & female teachers for 1993-94	2.77	1.31
5	Pupil Teacher Ratio	PTRATIO	Total enrolment of class I - V / NUMTCH	69.98	38.52
6	Percent female Teachers	PCTFEMT	Female teachers * 100 / NUMTCH	18.48	30.91

Appendix - I (Cont)

No	Variable	Label	Description	Mean	SD
Climate of School (All variables are Centred at school Level)					
1	Academic Press in Language	PRESSLNG	Teacher ask to read give dictation in class never=0 some times=1 every day=2 average by valid responses aggregated	1.48	0.40
2	Academic Press in Math	PRESSMTTH	Teacher give math problems to solve in class Never=0 Some times=1 Every day=2, Aggregated	1.40	0.43
3	Academic Press Test & Feedback	PRESSTST	Teacher give test & feedback to student for test never=1 once a while=2 once in a year=3 once in a term=4 once in a month=5 once in a week=6 for feedback not applicable=1 never=2,some times=3,always=4,average by logit aggregated	0.8	0.64
4	Academic Press Teacher Give Home Work	PRESSTHW	Teacher assign correct home work Never=0 some times=1 always/regularly=2 Average by valid response Aggregated	1.43	0.51
5	Academic Press Pupil Doing Home work	PRESSPHW	No & do not do home work=0 less than 30 minutes=1 30-60 minutes=2 61 120 minutes=3 over 120 minutes=4 aggregated	2.38	1.12
6	Teachers Commitment	COMMIT	Teacher come to class rarely=1 sometimes=2 most of the days=3 every day=4 teacher provide special help never=1 sometime=2 always=4 average by valid responses after logit aggregated	0.4	0.68
7	Parent Involvement	PRNTINV	Parent teacher meeting & meeting parents never=0 once in a year=1 once in a term=2 once in a month=3 once in a week=4 Average by valid responses Aggregated	2.19	0.87
8	Head Teacher as Leader	HMLEADER	Reviewing the performance of his / her class and all classes never=0 once in a year=1 once in a term=2 once in a month =3 once in a week=4,average by valid responses aggregated	2.02	1.09
No	Variable	Label	Description	Mean	SD
Intervention Variables (All variables are centred at school level)					
1	Operation Blackboard Scheme	OPBLACK	Record OPBLACK=1 Use=0	0.63	0.48
2	Material as per OB scheme	FACIOP	Add all yes=1 for 22 items (1 maps 2 globe, 3 charts 4 play material & toys 5 games equipment 6 primary school kit 7 mini tool kit 8 mathematic kit, 9 books for library- reference dictionaries,encyclopedia 10 books for library children book 11 books for library magazines,journal,newspaper 12 school bell 13 musical instruments 14 mats & furniture for student 15 chair for teachers 16 tables for teachers, 17 blackboard 18 chalk & duster 19 water picher landle glasses, 20 dustbin 21 safe drinking water 22 toilet facilities)	11.66	5.11
3	Other Scholarship	OSCHOLAR	Percentage of beneficiaries = ((male+female)/enrolment in primary classes) * 100	24.51	17.47

APPENDIX - II

HLM Model

Null Model:

It specifies the following student level model for each school

$$(\text{Outcome})_{ij} = \beta_{0j} + \epsilon_{ij} \quad (1)$$

Where $(\text{Achievement})_{ij}$ is the mathematics or language scores for pupil i in the school j . β_{0j} is the school mean of either outcome of j school and ϵ_{ij} is the student level residual

The between school model is

$$\beta_{0j} = \Phi_{00} + u_{0j} \quad (2)$$

Where Φ_{00} is the weighted average across the j th school and u_{0j} is the school level residual

Pupil Level Model (Level-1).

The student level model is

$$(\text{Outcome})_{ij} = \beta_{0j} + \beta_{1j}(\text{Girl}) + \beta_{2j}(\text{SES}) + \epsilon_{ij} \quad (3)$$

Out of these 9 pupil background variables, the variables having significant effect size or significant variation across the school are finally kept in the model. Variables with significant effect size but insignificant random variation are constrained

The school level model for these regressions includes a separate equation, like equation 2, for each of the β_j 's

$$\beta_{pj} = \Phi_{p0} + u_{pj} \quad \text{for } p = (0 \dots 9)$$

School Level Model (Level-2):

The student level model is like equation 3

At school level the β_{0j} regressed in four separate model including cluster of variables on Teacher quality, School resources, Climate of School and Intervention variables. Each model includes contextual variables before adjusting these four categories of variables

Unadjusted Gap

Pupil Level Model is

$$(\text{Outcome})_{ij} = \beta_{0j} + \beta_{1j}(\text{Girl}) + r_{ij} \quad (4)$$

Separate model is framed for SC,ST,OBC by replacing girl at slope (β_{1j}

School level model

$$\begin{aligned} \beta_{0j} &= \Phi_{00} + u_{0j} \\ \beta_{1j} &= \Phi_{10} + u_{1j} \end{aligned} \quad (5)$$

Adjusted Gap

Pupil level model is same as (3)

But school level model, where random effect was not significant, the variable was constrained. In this case the model was

$$\begin{aligned} \beta_{0j} &= \Phi_{00} + u_{0j} \\ \beta_{1j} &= \Phi_{10} \end{aligned}$$

Wherever the slope variance was not constrained, the β_{1j} was further regressed on schooling process variables